(Bio)methane direct catalytic conversion to (bio)ethylene in fluidized bed reactors

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The Oxidative Coupling of Methane (OCM) represents a promising reaction for (bio)methane valorization, because, making use of metal oxides as heterogeneous catalysts, it allows its direct conversion to (bio)ethylene, as first step towards the sustainable production of chemicals [1]. However, the commercial implementation of this reaction is hampered by low selectivity at high conversion, due to primary and consecutive oxidation reactions, and by high exothermicity of both selective and unselective reaction steps [2].

A promising solution in this respect could be represented by turbulent fluidized bed reactors. This reactor technology is characterized by improved heat management compared to fixed-bed reactors, hence facilitating the possibility of operating the reactor isothermally. Compared to other fluidized bed alternatives, turbulent beds present enhanced interphase mass transfer and reduced back-mixing compared to bubbling beds, thus promisingly offering higher selectivities. Denser beds, lower attrition and reduced entrainment, potentially resulting in higher mechanical stability of the catalyst particles, also make turbulent beds more attractive compared to beds operated in the fast fluidization regime [3].

Only few studies concerning the modelling of the turbulent reactor performances for OCM are available [4]. Additionally, none of these studies features detailed kinetics which can be extrapolated to wider ranges of operating conditions. Hence, the goal of the present work is to bridge this gap, by means of implementing a microkinetic model [5] into an engineering reactor model for turbulent fluidized bed reactors [6]. More specifically, the aim is to quantify the impact of interphase mass transfer limitations and axial dispersion on (bio)methane conversion and selectivity to the desired C_{2+} products.

Such a modelling effort is expected to set the basis for the simultaneous screening of operating conditions and catalyst properties in the turbulent fluidization regime, ultimately aimed at maximizing (bio)ethylene yield.

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